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ABSTRACT

An integrated program is presented that focuses on helping students understand the scientific principles behind the natural events they experience and the technologies they use daily in their lives. Students' abilities are developed to ask questions, investigate and experiment, gather, analyze and assess scientific laws and principles and their applications. In the process, students exercise their creativity and develop critical thinking skills. Through experimentation, problem-solving activities and independent study, students develop an understanding of the processes by which scientific knowledge evolves. Included are the program rationale and philosophy, general learner expectations, specific learner expectations, and a course overview. The four units are: (1) "Energy from the Sun"; (2) "Matter and Energy in Living Systems"; (3) "Matter and Energy in Chemical Change"; and (4) "Energy and Change". Each unit contains an overview, attitudes encouraged of students, major concepts, science knowledge, science skills, and science-technology-society connections. This final draft is being used to prepare support material and to validate the course of studies. (KR)

Science 10

PROGRAM RATIONALE AND PHILOSOPHY

Science by its nature is interesting, exciting and dynamic. Through the study of science students are given the opportunity to explore and understand the natural world and to become aware of the importance of science to their lives. Meaningful learning takes place when the study of science relates to what learners already know, deem personally useful and consider relevant. Young people learn best from concrete experiences that present an authentic view of science. In Science 10 students learn science in relevant contexts and engage in meaningful activities. This facilitates the transfer of knowledge to new contexts. Students are encouraged to participate in life-long scientific learning and to appreciate science as a remarkable, inspiring and stimulating human enterprise with practical impact on their lives and on society as a whole.

Science is experimental, creative and imaginative; methods of inquiry characterize the study of science. In Science 10 students further develop their ability to ask questions, investigate and experiment; to gather, analyze and assess scientific information; to test scientific laws and principles and their applications. In the process, students exercise their creativity and develop critical thinking skills. Through experimentation, problem-solving activities and independent study, students develop an understanding of the processes by which scientific knowledge evolves.

A thorough study of science is required to give students an understanding of science that encourages them to make appropriate applications of scientific concepts to their daily lives. Students are expected to participate actively in their own learning; teachers act as collaborators or guides. An emphasis on the key concepts and principles of science provides students with a more unified view of the natural sciences and a greater awareness of the connections among them.

Goals

The major goals of the Science 10 program are:

- to help students attain the level of scientific awareness that is essential for all citizens in a scientifically literate society
- to help students make informed decisions about further studies and careers in science
- to provide students with opportunities for personal development.

Science 10 is an integrated academic course that helps students better understand and apply the fundamental concepts and skills that cut across biology, chemistry and physics. It is a prerequisite for the 20-level science courses. Primarily, the focus is qualitative to help students understand the scientific principles behind the natural events they experience and the technologies they use daily in their lives. It encourages enthusiasm for the scientific enterprise and develops positive attitudes about science as an interesting human activity with personal meaning. It develops in students the attitudes, skills and knowledge to help them become capable of and committed to, setting goals, making informed choices and acting in ways that will improve their own lives and that of their communities.

GENERAL LEARNER EXPECTATIONS

The general learner expectations outline the many facets of scientific awareness and serve as the foundation for specific learner expectations. The general learner expectations are developed through the study of individual units in Science 10 and, though listed sequentially, they are not meant to be developed sequentially or separately.

Attitudes

Students will be encouraged to develop:

- an enthusiasm for, and a continuing interest in, science
- the effective attributes of scientists at work; such as, respect for evidence, tolerance of uncertainty, intellectual honesty, creativity, objectivity, perseverance, cooperation, curiosity and a desire to understand
- positive attitudes toward scientific skills involving mathematics, problem-solving and process skills
- a sensitivity to the living and non-living environment
- an appreciation for the roles of science and technology in our understanding of the natural world.

Skills

Students will develop an ability to:

- pose questions, define problems, formulate hypotheses, identify variables and design and carry out experiments to test ideas
- evaluate hypotheses on the basis of experimental evidence
- gather, organize and analyze information; communicate findings
- make connections between new information and prior knowledge
- evaluate and assess ideas and information.

Knowledge

1. Science Knowledge

Students will be expected to demonstrate an understanding of the key concepts and principles of science that transcend the discipline boundaries and show the unity among the natural sciences, including:

- Change: how all natural entities are modified over time, how the direction of change might be predicted and, in some instances, how change can be controlled
- Diversity: the array of living and non-living forms of matter and the procedures used to understand, classify and distinguish those forms on the basis of recurring patterns
- Energy: the capacity for doing work which drives much of what takes place in the universe through its variety of interconvertable forms
- Equilibrium: the state in which opposing forces or processes balance in a static or dynamic way
- Matter: the constitutive parts and the variety of states of the material in the physical world
- Systems: the interrelated groups of things or events that can be defined by their boundaries and, in some instances, by their inputs and outputs.

2. Science Process

Students will be expected to demonstrate an understanding of the processes by which scientific knowledge is developed, including:

- the central role of experimental evidence in the accumulation of knowledge
- the way in which proposed theories may be supported, modified or falsified by experimental evidence.

3. Science, Technology and Society

Students will be expected to demonstrate an understanding of the interdependent relationships of science, technology and society, including:

- the functioning of products or processes based on scientific principles
- the ways that science advances technology and technology advances science
- the use of technology to solve practical problems
- the limitations of scientific knowledge and technology
- the influence of the needs, interests and financial support of society on scientific and technological research
- the ability and responsibility, through science and technology, that society has to protect the environment and judiciously use natural resources to ensure quality life for future generations.

SPECIFIC LEARNER EXPECTATIONS

The specific learner expectations consist of the attitudes, skills and knowledge that are to be addressed in Science 10. The use of the learning cycle allows students to progress from:

- the experiential exploration of a new idea or content, through
- a hypothesis-building stage where concepts are developed to describe the results of the initial exploration; to
- an application phase where the hypothesis, vocabulary and patterns previously developed are applied to new situations.

Students examine phenomena in a variety of areas to show the relationships among the traditional science disciplines. Wherever possible, examples are drawn from their own experience to enable students to make the connection between the earth and the society around them, the technologies that societies have developed and the nature of science itself.

COURSE OVERVIEW

Science 10 emphasizes three of the key concepts of science: energy, matter and change. The concepts of systems, diversity and equilibrium are included as well but receive less emphasis. The conceptual themes provide a means of showing the connections among the scientific disciplines, and provide a framework for teachers to show students how individual sections of the course relate to the big ideas of science.

Science 10 consists of four units of study:

Unit 1 Energy from the Sun
Unit 2 Matter and Energy in Living Systems
Unit 3 Matter and Energy in Chemical Change
Unit 4 Energy and Change.

Unit 1 focuses on the role of radiant energy from the sun in sustaining life and driving weather systems on Earth. In Unit 2 the processes by which matter and energy are exchanged between living systems and their environment are studied, and change is illustrated by the growth of living organisms. Unit 3 investigates the changes in matter and energy that occur during chemical reactions. Unit 4 examines different forms of energy and the principles that govern energy transformations.

Unit 1
Energy from the Sun

Overview

The major theme of this unit is that radiant energy from the Sun sustains life and drives weather systems on Earth. The three major concepts presented in the unit are that photosynthesis in green plants maintains life on Earth, that weather systems are driven by solar energy moving through the atmosphere and the hydrosphere, and that the properties of water profoundly influence the nature of life on Earth. The concepts and skills developed in the unit build directly upon Science 8 Unit 5: Growing Plants, and Science 9 Unit 3: Heat Energy: Transfer and Conservation.

Aspects of the nature of science emerge from the knowledge and skills developed in the unit. The role of empirical evidence in formulating and revising theories and models is illustrated by a study of meteorological phenomena. The knowledge and skills are presented to encourage development of science inquiry skills in students. The relationship between science and technology is explored by a study of how weather systems are monitored. Examination of the impact of changes in weather and climate on human populations, and the importance of monitoring and predicting these phenomena, illustrates the connections among science, technology and society.

The attitudes, skills and knowledge developed in this unit provide students with a foundation for the study of global ecosystems and alternative energy sources in the 20- and 30-level science courses.

Attitudes

Students will be encouraged to:

- develop a questioning attitude concerning natural phenomena
- appreciate the importance of solar energy in sustaining life and driving weather systems on Earth
- appreciate the importance of water in determining the nature of life on Earth
- recognize that scientific knowledge of meteorological phenomena is cumulative and subject to change
- respect the role of empirical evidence in developing scientific theories related to weather
- recognize the limits of current scientific theories in predicting natural phenomena such as weather.

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
	Students will be able to:
1. Energy from the Sun sustains life on Earth.	1. Demonstrate an understanding that energy from the Sun sustains life on Earth by: 1.1 defining photosynthesis as the process by which green plants put together carbon dioxide and water to form carbohydrates and oxygen 1.2 indicating that all life on Earth exists in the *biosphere*, a relatively thin spherical shell having an approximate thickness of 15 kilometers 1.3 indicating that the biosphere exists within the three major spherical layers of Earth — the atmosphere, the hydrosphere and the lithosphere.
2. Weather systems are driven by energy from the Sun.	2. Demonstrate an understanding that weather systems are driven by energy from the Sun moving through the atmosphere and hydrosphere by: 2.1 relating latitude and surface characteristics (e.g., snow, oceans, forests) to the amount of solar energy absorbed and lost by Earth 2.2 explaining the significance of the differential solar heating of equatorial and polar regions in the transfer of thermal energy 2.3 recalling from junior high science that heat is a form of energy and may be quantified using $Q = mc(T_2-T_1)$ 2.4 calculating the thermal energy involved when a measured mass of water undergoes a measured temperature change 2.5 explaining the formation of hurricanes, using the theory of cold and warm fronts and the Coriolis effect

SCIENCE SKILLS	STS CONNECTIONS
Students will be able to:	*Students will be able to* demonstrate an understanding of the interrelationship of science, technology and society by; for example:
• perform an experiment to investigate the production of carbohydrates and oxygen by green plants	• discussing the implications of glo⌊al deforestation for the human race
• trace the flow of energy through the biosphere using diagrams	• describe the technology used to monitor levels of atmospheric gases
• communicate the findings of their investigations in a clearly written report	• tracing the energy contained in a typical student lunch to its source ın the Sun
• design an experiment to investigate the heating effect of solar energy	• describing the operation of weather satellites in monitoring weather systems
• evaluate meteorological models currently used to explain and predict weather patterns	• describing the operation of radar in tracking thunderstorms
	• explaining how more accurate weather predictions could benefit millions of people globally

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
	2.6 explaining the formation of tornadoes in terms of vertical air currents and a cold front 2.7 explaining the formation of thunderstorms and hailstorms in terms of vertical air currents 2.8 explaining the occurence of chinooks in terms of the heat produced by the compression of air 2.9 expressing meteorological data in SI units; e.g., temperature, wind velocity, atmospheric pressure, precipitation 2.10 explaining cyclical changes in climate in terms of rotation of Earth on its axis and around the Sun
3. The properties of water profoundly influence the nature of life on Earth.	3. Demonstrate an understanding that the properties of water (e.g., melting point, boiling point, heat of fusion, heat of vaporization, expansion on freezing, maximum density at four degrees Celsius) profoundly influence the nature of life on Earth by: 3.1 relating the hydrologic cycle to solar energy 3.2 relating the properties of water to the maintenance of constant body temperature 3.3 indicating why ice forms on the surface of water, and relating this to the winter survival of aquatic organisms 3.4 explaining why large bodies of water have a moderating affect on the climate of the surrounding area 3.5 describing the role of ocean currents in transferring thermal energy; e.g., Gulf Stream, Japan Current, El Nino

SCIENCE SKILLS	STS CONNECTIONS
• perform an experiment to investigate the heat changes involved in the compression and expansion of air	• identifying natural phenomena locally that show cyclical changes; e.g., hours of daylight, angle of sun's rays • relating seasonal variations in local climate to the tilt of Earth's axis.
• collect and graph data showing the effect of heating on the temperature of water • perform an experiment to determine the heat of fusion of ice • design an experiment to investigate the change in volume of water on freezing • compare mean monthly temperature data for cities of similar latitude and account for any differences	• explaining why perspiration can keep a person from overheating on a hot day • describing how the expansion of water, upon freezing, is accounted for in construction in cold climates • explaining technologies that use solar energy to desalinate water in terms of the scientific principles involved • describing technologies that use water to maintain a uniform temperature in buildings in terms of the scientific principles involved.

Unit 2 Matter and Energy in Living Systems

Overview

Change, matter and energy, key ideas of science, are developed by the study of growth in living organisms. Energy and matter are exchanged between living systems and their environment, with the major energy source being the Sun. Other secondary themes developed are: equilibrium, as the functional maintenance of homeostasis; systems, as the structures used to maintain equilibrium; and diversity, as the range of organisms in which selected biological processes are studied.

Living organisms are introduced as variations on a basic cell structure. By examining the energetic principles underlying photosynthesis, the study of cellular processes builds upon Science 8 Unit 5: Growing Plants and Unit 6: Interactions and Environments. The energetics of diffusion, osmosis and active transport are analyzed. The limitations diffusion places on growth and the significance of the evolution of transport systems in multicellular organisms is examined. The adaptations of selected organisms to carry out exchange processes with the environment are surveyed. The structures where the organisms interface with the environment are studied from a functional point of view. By selecting representative organisms, this study further develops the theme found in Science 9 Unit 1: Diversity of Living Things.

Aspects of the nature of science are illustrated by the use of mathematics to calculate surface to volume ratios and then using that data to infer limitations on cellular processes. Process skills are developed by the use of observation, description and experimentation during laboratory activities. The relationship between science and technology is illustrated by the use of microscopes to examine cell structure and by exploring applications of the principles of osmosis to the solving of practical problems. The connections among science, technology and society can emerge through the investigation of an issue relevant to the students and to this unit.

The attitudes, skills and knowledge developed in this unit provide students with a sound background for the further study of biology in Science 20 and Biology 20.

Attitudes

Students will be encouraged to:

- appreciate the unity of science through the application of physical and chemical principles to biological systems
- appreciate that biological principles emerge from the investigation of the structure and functioning of living systems
- appreciate the fact that many fundamental biological processes operate at both the cellular and higher levels of organization
- appreciate that the maintenance of homeostasis relies on equilibria within the organism and between the organism and its environment
- develop an awareness of the human body as a biological entity governed by biological principles
- develop a curiosity to obtain a deeper understanding of biological systems
- appreciate that our knowledge of biology has been enhanced by the application of technology
- appreciate that the application of technology can have beneficial and harmful effects on biological systems.

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
	Students will be able to:
1. The cell is the basic unit of living systems.	1. Demonstrate an understanding that the cell is the basic unit of living systems by: 1.1 describing the structure of the cell membrane, nucleus, nucleoid, endoplasmic reticulum, Golgi apparatus, lysosome, vacuole, mitochondrion, chloroplast, ribosome, cytoskeleton and cell wall, where present, in bacteria, plant and animal cells 1.2 identifying the functions of the membrane and subcellular organelles.
2. Growth is a major feature of living systems and a major limitation to growth is the surface to volume ratio of the cell.	2. Demonstrate an understanding of growth as a major feature of living systems and how the major limitation to growth is the surface to volume ratio of the cell by: 2.1 describing what is meant by growth in terms of both an increase in the number of cells by fission or mitosis, and the increase in size or weight of a cell or organism 2.2 describing how the surface to volume ratio of a cell might limit its growth, and inferring the value of multicellularity in enhancing the ability to use nutrients 2.3 explaining how division of labour occurs within a single cell and, after the process of differentation, in a multicellular organism.

SCIENCE SKILLS	STS CONNECTIONS
Students will be able to:	*Students will be able to* demonstrate an understanding of the interrelationship of science, technology and society by; for example:
• identify cellular structures in living and prepared material using dissecting and compound microscopes and by examination of electron micrographs • prepare plant and animal material for microscopic examination by using stains and observing the materials • estimate the size of cellular structures identified from a knowledge of microscope magnification power • communicate the finds of their investigations in a clearly written report	• drawing analogies between the division of labour within cells to that of the functional systems of the human body or of a community • describing how developments in the technology of microscopes has led to an increase in our knowledge and understanding of cell structure • researching the development of the electron microscope, a Canadian invention
• calculate and graph the surface to volume ratios of a variety of model cell sizes and shapes • compare the surface to volume ratio of various organisms and relate the findings to the organisms metabolic rate; e.g., humming bird or shrew compared elephant or whale	• identifying and explaining how technological and natural systems demonstrate that surface area maximization facilitates the transfer of heat, gases, nutrients or wastes; e.g., car radiator, fish gill, intestinal villi, elephant ears, dialysis machine, aquarium pumps, heart-lung machine, alveoli, nasal membranes, capillary networks, roots and leaves

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
3. The cell is an open system exchanging matter and energy with the environment.	3. Demonstrate an understanding that the cell is an open system exchanging matter and energy with the environment by: 3.1 describing how materials diffuse across a cell membrane in terms of energy gradients 3.2 describing how the semipermeable nature of the cell membrane allows the process of osmosis 3.3 describing how metabolic energy may be used to do the work of transporting substances across membranes against their concentration gradients 3.4 describing, in general terms, how the energy for active transport is derived from photosynthesis and respiration in the form of adenosine triphosphate (ATP) 3.5 describing, in general terms, how the energy in light is stored in plant chloroplasts and then transferred for storage in ATP molecules 3.6 describing, in general terms, how carbon dioxide in solution, or in the air, is fixed as carbohydrates using the stored light energy in the plant chloroplasts

SCIENCE SKILLS

- investigate the different action of sodium chloride solution and starch solution when placed in separate dialysis bags and immersed in water and infer why the solutions behave differently
- perform an experiment to demonstrate the phenomena of plasmolysis and deplasmolysis in plant cells (e.g., staminal hairs or aquatic leaf cells) and describe the observed events in terms of the tonicity of the cells and solutions
- infer how biochemical interconversion of starch and glucose might regulate the turgor pressure of cells
- observe and diagram the locomotion of *Amoeba* and infer how this movement relates to the process of endocytosis and exocytosis
- observe and/or research the nutrient acquisition of selected protists, plants and animals, and describe such processes with clearly labelled diagrams

STS CONNECTIONS

- explaining how a dialysis machine or the process of peritoneal dialysis can be used to treat people with kidney dysfunction
- explain how eating solid food can provide one with nutrition
- explaining how a knowledge of diffusion and osmosis can be used in industrial applications; e.g., the desalination of seawater
- describing how the ability to compress gases has enabled humans to climb high mountains and work in deep oceans
- explaining what is occurring when a person suffers from altitude sickness, or caisson disease
- summarize articles from periodicals regarding the latest scientific and/or technological developments; e.g. kidney research

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
4. Multicellular organisms provide for the matter and energy needs of cells at a distance from the organism's interface with the environment.	4. Demonstrate an understanding of how multicellular organisms provide for the matter and energy needs of cells at a distance from the organism's interface with the environment by: 4.1 comparing and contrasting how the selected organisms transport nutrients and wastes over short and long distances, and discussing the differences in terms of the biology of the organisms 4.2 comparing and contrasting how selected organisms acquire nutrients and remove wastes, and discussing the differences in terms of the biology of the organisms 4.3 comparing and contrasting how selected organisms exchange gases, and discussing the differences in terms of the biology of the organisms.

SCIENCE SKILLS	STS CONNECTIONS
• observe the limitations of diffusion in macroscopic systems by placing a dye crystal in water, observe how stirring the mixture improves the speed of dye transport, and infer how pushing it down a pipe would be a more efficient form of transport • observe and describe the appearance of cytoplasmic streaming in *Amoeba* or a plant cell and infer similar movement in most cells of a multicellular organism • identify diverse pairs of organisms and compare them with respect to transport systems; i.e. *Amoeba* and giraffe, a single celled alga and a redwood tree	• drawing appropriate analogies for nutrient distribution in multicellular organisms; e.g., animal versus factory • researching and explaining how the vacuum tapping system, invented by a Canadian, takes advantage of the natural transport system of maple t[illegible] • describing how a systemic pesticide is taken up and distributed throughout a plant; e.g., the fungicide used to treat Dutch Elm Disease • discussing the positive and negative features of commonly used systemic pesticides

Unit 3 Matter and Energy in Chemical Change

Overview

The major idea developed in this unit is that energy and matter are involved in chemical reactions. This unit builds on Science 8 Unit 1: Solutions and Substances, and Science 9 Unit 5: Chemical Properties and Changes, in which students began to observe and classify matter according to physical and chemical properties and then progressed to a study of chemical change. In this unit, students review the categories of matter and begin to understand that there is an order in the properties of elements that scientists have used in the development of the periodic table. The vast array of compounds created by combining elements shows that diversity is often the result of change. This diversity demonstrates the need for a system of nomenclature. The concept of chemical change introduced in Science 9 Unit 5: Chemical Properties and Change is expanded to an understanding of chemical reactions as systems involving energy, the categorization of chemical reactions, and writing word and chemical equations. The description of the underlying structure of matter in terms of subatomic and atomic species helps students to understand the conservation of matter in chemical change. Calculations related to the mole and molar mass introduce students to quantitative aspects of chemistry. The nature of science is exemplified by examining the role of empirical evidence in the development of a scientific understanding of the structure of matter.

Science and technology contexts are illustrated by technological processes that are based on principles of chemical change. The relationship among science, technology and society is explored in the examination of the benefits and hazards of natural and synthetic substances.

The attitudes, skills and knowledge developed in this unit provide students with a foundation for the further study of chemistry in Chemistry 20/30 and Science 20/30.

Attitudes

Students will be encouraged to:

- foster curiosity about the structure and changes of matter
- appreciate the orderliness of nature and the characteristic pattern in the properties of matter
- appreciate that careful and precise observations form the basis for generalizations about the nature of matter
- tolerate the uncertainty in our explanations of the nature of matter
- develop a positive attitude toward mathematical and scientific process skills as well as memorization skills in learning the language of chemistry
- value the contribution of science and technology to our understanding of the nature of matter
- value the need for safe handling and disposal of chemicals
- demonstrate an awareness of the impact that humans have had on the environment through the manipulation of matter for personal and industrial use
- appreciate the benefits that have resulted from applications based on chemical principles.

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
	Students will be able to:
1. Matter is everything that has mass and occupies space.	1. Demonstrate an understanding that matter is classified on the basis of properties by: 1.1 recalling from junior high science the major categories of matter (e.g., pure substance, mixture, element, compound, solution) and the differences between physical and chemical properties 1.2 explaining the classification of elements in the periodic table in terms of chemical properties 1.3 predicting the properties of elements from their position on the periodic table and the placement of elements on the periodic table from their properties 1.4 naming and writing symbols for the first 20 elements and other common elements 1.5 identifying the elements that are most prevalent in living systems.
2. Energy is involved in each change that matter undergoes.	2. Demonstrate an understanding of the changes that matter undergoes by: 2.1 differentiating in terms of energy and matter between physical, chemical and nuclear changes 2.2 identifying types of chemical reactions; e.g., synthesis or combination, endo/exothermic, decomposition, displacement or substitution, combustion 2.3 researching alternative reactions for producing energy and chemicals 2.4 writing word equations for chemical reactions that occur in living and non-living systems

SCIENCE SKILLS	STS CONNECTIONS
Students will be able to:	*Students will be able to* demonstrate an understanding of the interrelationship of science, technology and society by; for example:
• use observation and experimentation to study the properties of matter, and to classify various examples of matter	• relating the properties of water to the transportation of nutrients and wastes in living systems • describing the application of common separation techniques such as filtration, extraction, distillation and chromatography
• observe chemical and physical properties of representative elements, noting the patterns • communicate the findings of their investigations in a clearly written report	• listing some examples of elements that are hazardous to human health and the environment • describing some of the physiological effects of heavy metals such as lead and mercury and the possible sources of contamination in everyday life • explaining why most metals must be separated from their ores and protected to prevent corrosion

• perform experiments that illustrate chemical changes, taking care to:
  • use equipment such as a bunsen burner and laboratory glassware correctly and safely
  • handle and dispose of chemicals in a safe, responsible manner
	• providing examples of processes that use physical and/or chemical changes to produce useful substances and energy
	• identifying chemical reactions that are harmful to the environment; e.g., destruction of the ozone layer by chloroflurocarbons, formation of acid rain and greenhouse gases
	• disposal of household hazardous wastes

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
3. Elements combine to form a vast array of compounds.	3. Demonstrate an understanding that elements combine to form compounds which have characteristic properties and are assigned individual names by 3.1 differentiating, on the basis of properties (conductivity, pH, etc.), among ionic and molecular compounds and acids 3.2 identifying the role of several compounds in living systems 3.3 naming and writing formulas for selected compounds.
4. Matter has a well-defined underlying structure.	4. Demonstrate an understanding that matter consists of atoms, ionic species and molecules by: 4.1 providing definitions for the following chemical species: atom, (isotope, radioisotope), ionic species, molecule 4.2 indicating the relative sizes of chemical species compared to micro- and macroscopic species 4.3 describing the extent to which we are able to observe chemical species with modern technology.
5. Matter is conserved in chemical changes.	5. Demonstrate an understanding that the conservation of mass in chemical changes can be illustrated and quantified by: 5.1 outlining experiments, such as van Helmont's, showing that plants combine with something other than soil 5.2 writing chemical equations that include the state of matter for each substance and balancing the equations in terms of chemical species and moles.

SCIENCE SKILLS	STS CONNECTIONS
• investigate the properties of representative compounds in laboratory experiments and in resources such as a chemistry handbook	• researching the synthesis and uses of new materials with different properties using current periodicals • listing several common compounds that are essential to human health • listing several common compounds that are hazardous to human health and the environment • discussing the disposal problem related to used materials • outlining safe methods for handling hazardous substances in the home
• build models of the structure of the atom including protons, neutrons and electrons, their relative size, charge, mass and position	• illustrating with examples how radioactive substances are used in medical research and treatment • discuss the merits of spending public money on investigating atomic structure
• perform an experiment that demonstrates the principles behind Lavoisier's experiments on combustion, which led to the conclusion that burning substances gain mass by combining with oxygen from the air • illustrate through measurements and calculations involving moles and molar masses that matter is conserved in chemical reactions	• explaining the use of balances in analytical chemistry • using a calculator for calculations involving moles.

Unit 4
Energy and Change

Overview

Two key ideas of science, energy and change are central to this unit. The ideas of diversity (as illustrated by the many forms of energy) and systems play a lesser role in the unit. The concepts of force, motion and work, first introduced in Science 7 Unit 3: Force and Motion, and Science 8 Unit 2: Energy and Machines, are recalled and related to energy and energy transfer. Building on the development of the concepts of energy, energy transfer, and heat introduced in Science 7 Unit 4: Temperature and Heat Measurement, and Science 9 Unit 3: Heat Energy: Transfer and Conservation the student is introduced to a more formal treatment of thermodynamics. The unit extends the concepts of energy and energy conservation and transformation, discussed in Unit 1 and treated in their biological and chemical contexts in subsequent units, into the quantification of various forms of energy.

The nature of science is exemplified by the use of mathematics to describe and interpret energy and energy transformation observed in the physical world, and the continuous development of process skills through laboratory activities. Science and technology interactions emerge from the consideration of energy conversion devices and systems. By drawing attention to the use of energy, and the role of scientific principles in energy transfer, the social context of science is illustrated. The unit concludes with a project in which the student is to design and build a simple energy conversion device and evaluate its efficiency.

The attitudes, skills and knowledge developed in this unit provide students with a foundation for further study of energy and conservation related topics in Physics 20 and Science 20.

Attitudes

Students will be encouraged to:

- develop a positive attitude toward mathematical, communication and scientific processes and skills in the study of energy
- appreciate the need for computational competence in quantifying energy and energy transfers
- respect evidence when interpreting observed phenomena related to energy
- appreciate that science is a disciplined way to develop explanations and descriptions about energy in the natural and technological world
- accept uncertainty in our descriptions and explanations of observations related to energy in the physical world.

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
	Students will be able to:
1. Energy exists in a variety of forms, illustrating the diversity of nature.	1. Demonstrate an understanding that energy exists in a variety of forms (e.g., mechanical, chemical, electrical, thermal, nuclear and solar) by: 1.1 defining energy as the property of a system that is a measure of its capacity for doing work, and work as the transfer of energy 1.2 defining potential energy as energy due to position or condition, and kinetic energy as energy due to motion 1.3 recognizing chemical energy as a form of potential energy 1.4 illustrating by use of examples that the Sun is the source of most energy forms 1.5 recalling from Science 7 that thermal energy can be derived from a variety of sources 1.6 deriving the unit of energy and work, the joule, from fundamental SI units 1.7 analyzing units to describe the kilowatt hour as a unit of energy, and the watt as a unit of rate of energy transfer or a unit of doing work
2. Conservation of energy is fundamental to the functioning of the universe.	2. Demonstrate an understanding that energy is conserved, in a closed system, by: 2.1 stating the law of conservation of energy as the sum of initial energies is equal to the sum of the final energies

SCIENCE SKILLS	STS CONNECTIONS
Students will be able to:	*Students will be able to:* demonstrate an understanding of the interrelationship of science, technology and society by; for example:
• trace the flow of energy from the Sun to the lighting system in the school	• describing the technologies involved in current sources of energy • discussing the importance of the Sun as an energy source for life on Earth • discussing and analyzing the significance of wind chill measurements
• design an experiment to investigate the conservation of energy in a closed system • communicate the findings of their investigations in a clearly written report	• commenting on the feasibility of perpetual motion machines

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
	2.2 illustrating by use of examples that energy cannot be created or destroyed, only converted from one form into another, and recognizing this as a formal statement of the First Law of Thermodynamics and therefore, an application of the law of conservation of energy 2.3 describing by use of examples that thermal energy will, of its own accord, flow from a hotter body to a cooler body, and recognizing this as a formal statement of the Second Law of Thermodynamics 2.4 comparing and contrasting the mechanism of osmosis and thermal energy transfer according to the Second Law of Thermodynamics.
3. The transformation of energy from one form to another is a consequence of conservation.	3. Demonstrate an understanding that energy transformations can be measured by: 3.1 illustrating by use of examples that energy transfers produce measurable changes in motion, shape or temperature of matter 3.2 using the kinetic molecular theory as a simple mechanical model in explaining the effect of thermal energy on matter 3.3 describing temperature changes in terms of changes in the kinetic energy of the molecules of a substance 3.4 describing phase changes in terms of the kinetic molecular theory 3.5 recalling from Science 7 Unit 3 the notions of force, mass and weight 3.6 describing one-dimensional uniform motion using graphical and mathematical techniques

SCIENCE SKILLS	STS CONNECTIONS
• performing an experiment to demonstrate the similarities between osmosis and thermal energy transfer	
• calculate the energy consumption of selected household technologies: e.g., toaster, microwave oven or refrigerator	• describing current techr.ologies for converting energy form one form to another: e.g., hydroelectric and coal-burning power stations, solar cells
• perform an experiment to demonstrate the conversion of chemical potential energy to thermal energy involving a combustion reaction	• describing the energy transfers, and how they are achieved, in various conversion systems: e.g., refrigerator, heat pump, thermal power plant
• perform an experiment to determine the relationships among distance, speed and time	• describing technological devices that use chemical potential energy as an energy source
• determine speed and distance from distance-time and speed-time graphs	• using interval timers to investigate the relationships among distance, speed and time
• perform an experiment to demonstrate the equivalency of work done on an object and its resulting kinetic energy	• analyzing the energy transfers occuring as an automobile or a bicycle comes to a stop
• determine work done from a force-distance graph, and kinetic energy from a mass-velocity graph	• analyzing the movement of passengers in an automobile changing direction
	• comparing and contrasting the energy transfers and technologies involved in a hydroelectric and a thermal power plant
	• using laboratory equipment to investigate energy conversions

MAJOR CONCEPTS	SCIENCE KNOWLEDGE
	3.7 recalling from Science 8 Unit 2 the definition of mechanical work and quantifying the work done on/by an object using Work = Fd
	3.8 defining gravitational potential energy as the work done on a mass against gravity, and quantifying gravitational potential energy using PE = weight x height
	3.9 quantifying kinetic energy using $KE = 1/2mv^2$
	3.10 quantifying electrical energy using E = VIT.
4. A consequence of the Second Law of Thermodynamics is that the useful energy diminishes during any energy transformation.	4. Demonstrate an understanding that the amounts of useful energy diminishes in any energy transformation by:
	4.1 interpreting empirical data from a study of energy conversions
	4.2 determining the efficiency of an energy conversion, from measurements of the input and output energies.

SCIENCE SKILLS

- conduct an investigation in which the efficiency of common technological devices used to heat a specific amount of water is quantified and evaluated
- perform an experiment in which mechanical energy is converted into heat energy
- perform an experiment in which electrical energy is converted into heat energy
- design and build an energy conversion device and calculate its efficiency.

STS CONNECTIONS

- discussing the impact of displaying energy consumption labels on household appliances
- comparing and contrasting, quantitatively, the energy content of fuels used in thermal power plants in Alberta
- discussing the use of fossil fuels in thermal power plants in Alberta
- discussing the role of alternative energy sources to generate electricity in Alberta
- discussing the role of efficiency of energy conversion to encourage responsible energy use.
- outlining a local program of responsible energy use.